ZTR

Control Systems

What you have always wanted to know about idling locomotives……..

……..But were afraid to ask.

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What I hope to leave you with today is……

- *An understanding of some of the complexities involved with shutting down and restarting locomotives.*
- *How technology has helped to automate the performance of this task and turn it into a win-win situation.*
- *Some thoughts regarding sharing the costs of the benefits to be reaped*
- *One easy way to protect your investment*

Let’s start with some common ground…….

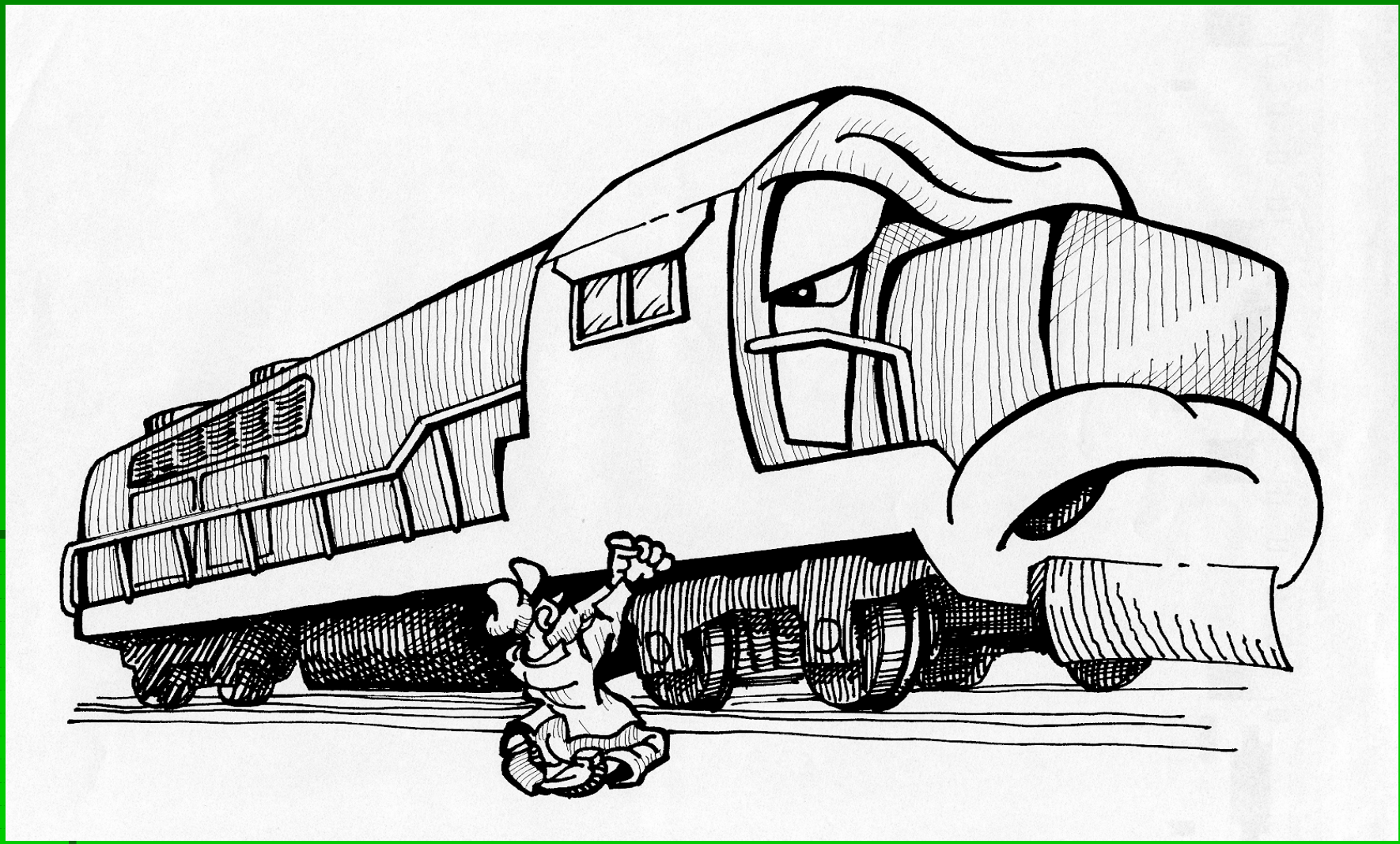
- Shutting down locomotives, when they are not being utilized, saves money and reduces emissions.

Now if we are all in agreement with this, then why are we here?

The answer is……

- Shutting them down is not the problem!

The problem lies in …..what happens <u>after</u> you shut them down….or try to get them to restart.



Some detrimental incidents that can arise while locomotives are shut down include……

- Batteries draining
- Coolant leaking into the cylinder
- Engine becoming “Cold Soaked”
- Outside temperature dropping below freezing
- The Dump Valve dumping the coolant

Manually restarting a locomotive engine, can in itself be a challenge…….

- Some locomotives can be 30 to 40 years old
- Dealing with a variety of different engines
- Horsepower ranges from 1000 to 3000+
- Differences in starting systems
- Unknown condition of batteries

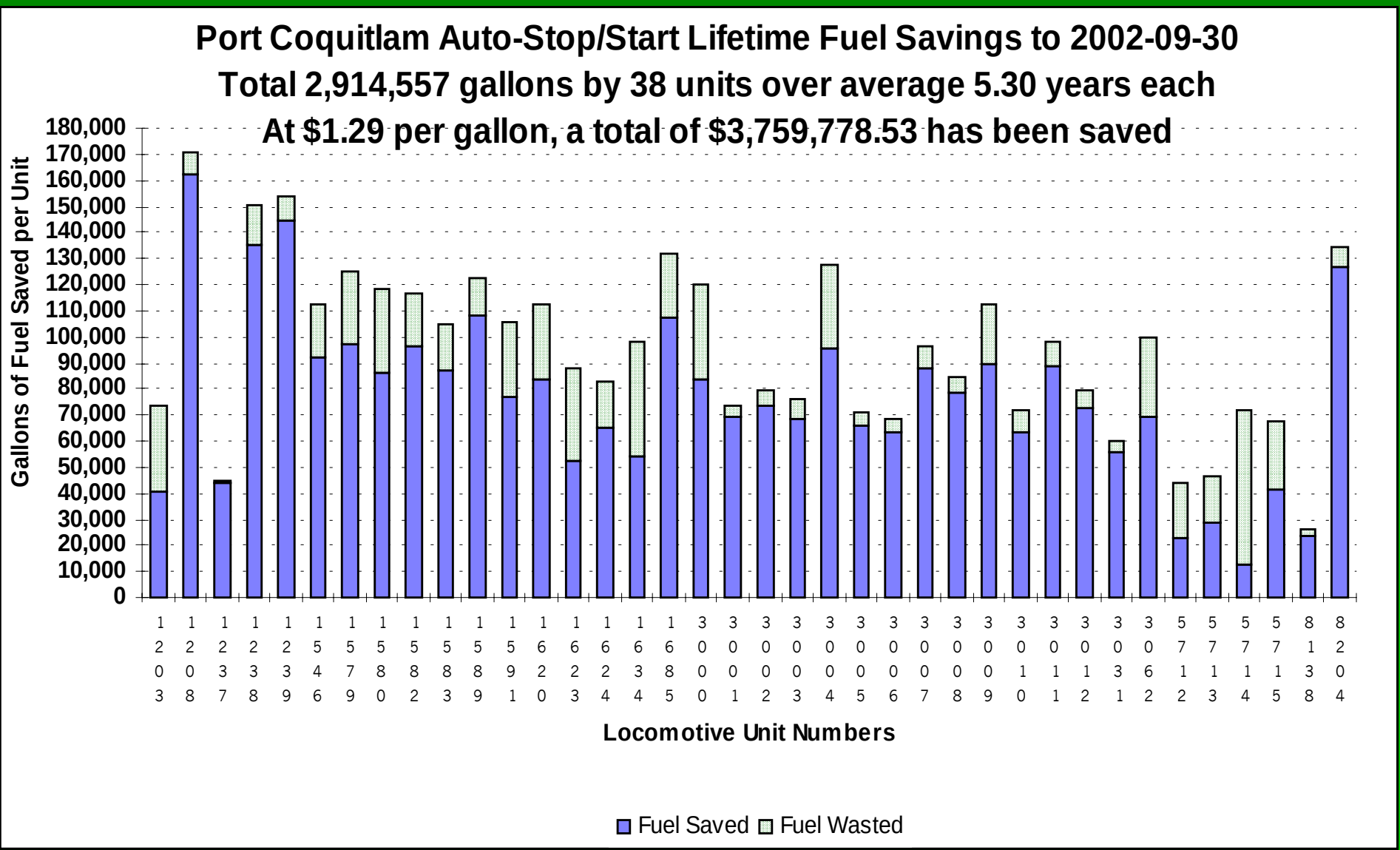
Successfully automating the process was complex and required a microprocessor based product like……

SmartStart

SmartStart was designed to meet stringent objectives…… Included among these was the need to……

- Determine if the locomotive should or could be shut down.
- Protect it while it was shut down.
- Be able to reliably restart it.
- Perform all of these tasks safely.
- Be durable enough to live in this environment
- Report on how well it performed its job.
- Provide the user with information not just data.

So how has SmartStart been doing?



SmartStart has saved our users millions and we're still counting…..

- **Actual Fuel Savings on *SmartStart* equipped locomotives operating on a Canadian Class 1 railroad:**

(Does not include any savings from their active manual shutdown policy)

Number of locomotives tracked	38
Average period per locomotive	5.3 years
Total fuel saved	2,914,557 gallons
Average fuel saved per locomotive	76,699 gallons
Average fuel saved per locomotive per year	14,471 gallons

- ***At about a buck a gallon for fuel ……not a bad payback!***

And….think of the reduction in emissions!

2,914,557 Gallons Saved

4 Gallons Per Hour at Idle = 728,639 Hrs. of Reduced Idle Time

A two cycle engine produces 800 Grams of NOx per hour at Idle

728,639 Hours of Reduced Idle X 800 Grams = 582,911,200 Grams of NOx

582,911,200 Grams/454grams per lb. = 1,283,945 lbs./2000 lbs. per ton =

642 Tons of NOx or 17 Tons Per Locomotive

17 Tons/5.30 Years = 3.2 Tons per Locomotive Per Year

How do we compile these statistics?

SmartStart Detail Report

Rail Road:
Road Number: 1682
Location: OpCenter Demo

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Reporting Period

	Installation	Previous Report	Current Report		Since Installation	Previous Report
Date:	12/2/1993	12/6/2003	1/3/2004	Days:	3683.9	28.0
Time:	16:24:06	13:15:50	13:17:46	Hours:	88412.9	672.0

Locomotive Operating Statistics (Hours)

	Since Installation			Since Previous Report		
In Service Hours:	74674.1	=	3111.4 Days	672.0	=	28.0 Days
Out of Service Hours:	13738.8	=	572.4 Days	0.0	=	0.0 Days

	Since Installation	Since Prev. Report		Since Installation	Since Previous Report
ENGINE SHUTDOWN:	32604.1	273.5	IDLING:	34585.6	389.8
Manual:	2862.4	0.0	Working Idle:	14692.5	56.7
SmartStart:	29741.7	273.6	Parked Idle:	19893.1	333.1
ENGINE RUN:	42070.0	398.5	PARKED IDLE:	19893.1	333.1
Loading:	7484.4	8.7	Unavoidable Idle:	11382.9	298.4
Idling:	34585.6	389.8	Manageable Idle:	8510.2	34.7

Unsatisfied Parameters Preventing Shutdown (Hours)

		UNAVOIDABLE			
Ambient Temp:	12207.8	298.5	Water Temp:	50.0	0.0
		0.0	High Water Temp:	0.0	0.0
		MANAGEABLE			
Brake Pressure:	2432.7	11.8	Battery Voltage:	0.0	0.0
Battery Charging:	1656.2	22.9	Extended Idle:	26.9	0.0
Reverser not Centered:	506.5	0.0	SS Switch Off:	4248.4	0.0

Reason(s) for Restart After SmartStart Shutdown (Counts) Shutdown (Counts)

Brake Pressure:	12090	78	Ambient Temp:	101	4
Water Temp:	4245	33	Battery Voltage:	1086	30
Reverser:	5587	6			
SmartStart Restarts:	23109	151	Other Restarts:	844	42

SmartStart Shutdown Information

Count:	23953	193	Time:	29741.70	273.60

SmartStart Savings Analysis

Savings Realized By SmartStart :	$ 153467.17	$ 1411.78
Additional Potential Savings NOT Realized By SmartStart:	$ 29641.03	$ 120.86
(Based on 67.5 % of Manageable Idle Hours)		

NOTE: Figures based on locomotive fuel consumption rate of 4.0 gallons/hr at $ 1.29/gallon.

135 / 22 / 11400 / 22833 / 58 / -40 / -40 / -40

Now think of the potential for tracking emissions reductions, credits, etc.

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SmartStart - Hotstart Emissions Report

Rail Road:

Location: OpCenter Demo

Road Number: 2133

HOTSTART

Reporting Period

	Installation	Previous Report	Current Report		Since Installation	Previous Report
Date:	8/28/2002	11/30/2003	12/9/2003	**Days:**	468.0	9.0
Time:	14:43:01	13:18:39	14:15:50	**Hours:**	11231.5	217.0

Summary

Gallons of fuel saved by SmartStart - Hotstart	14889.4	63.0
Shutdown hours due to SmartStart - Hotstart	2972.0	14.0

Reduction of Emissions

(Does not include emissions by Kim Hotstart DDHS)

Reduction in NOx due to SmartStart - Hotstart (pounds)	5237.0	24.7
Reduction in PM due to SmartStart - Hotstart (pounds)	170.2	0.8

(These calculations based on locomotive emissions as published by the EPA
Engine: EMD 2 Stroke Notch Position = Idle NOx = 800 g/hr PM = 26 g/hr)

SmartStart - Hotstart reduced the average weighted factor of NOx (g/bhp-hr) by (See table below)	0.9	0.2

Table

LOCOMOTIVE ENGINE EMISSIONS - BASELINE DIESEL FUEL

Engine	Notch	Engine Speed	Fuel Flow (lb/hr)	BHP	PM (g/hr)	HC (g/hr)	CO (g/hr)	NOx (g/hr)
EMD 12-645E3B	Idle	300	27	12	21.0	88.0	297.0	776.0

As published in a joint paper to the ASME (Vol 113, July 1991) by the AAR and Southwest Research Institute

What is preventing systems such as *SmartStart* from being applied to locomotives?

- The 3 M's
- **Money**
- **Manpower**
- **Motivation**

- ***Given that Money can usually solve items two and three ….the question then is how do you get the funding?***

One way to ask your Federal, State or Local Government to Assist

- Obviously there are benefits to be gained by all of these organizations as well.
- But like any good business person, they want to get a high return on their investment.

There have been several concepts put forth to accomplish this type of funding. To that list, I add another that may be of interest.

Shared Savings

Here is how it would work…

Initial System Costs per Locomotive (With Volumes)

- ***SmartStart* System Costs**
- **Remote Monitoring Costs**
- **Installation Costs**

Approximately $15,000

Historical Annual Payback in Fuel Savings Alone….

$14,471

(Based on 38 systems monitored for 5.3 years)

Let's be conservative and use $6,000 Annually in our scenario……

The Arrangement……..

- **The locomotive user/owner would be funded the full amount up front.**
- **The funding government body would receive $3,000 per year from the recipient on the investment over a five year period.**
- **At the end of five years, the cost to the funding government body to support emission reductions would be the cost of money.**
- **The cost per ton on NOx reduced is minimal.**

The Win-Win.....

- **Locomotive User/Owner**
  - **No initial outlay of capital**
  - **System pays for itself out of actual fuel savings**
  - **Owns the equipment and reaps <u>all</u> savings after the fifth year.**

- **The Funding Agency**
  - **Reduction in emissions**
  - **Payback on investment**
  - **Minimal cost per ton of NOx reduced**

Now you may be thinking.....

Hmmmm.....sounds good.....but then how do I protect my investment?

Now think in terms of:

- **Wireless Remote Downloading of Information from the Locomotive**

- **GPS**

- **Geo Fencing**

- **Secure Access to the Information over the Web**

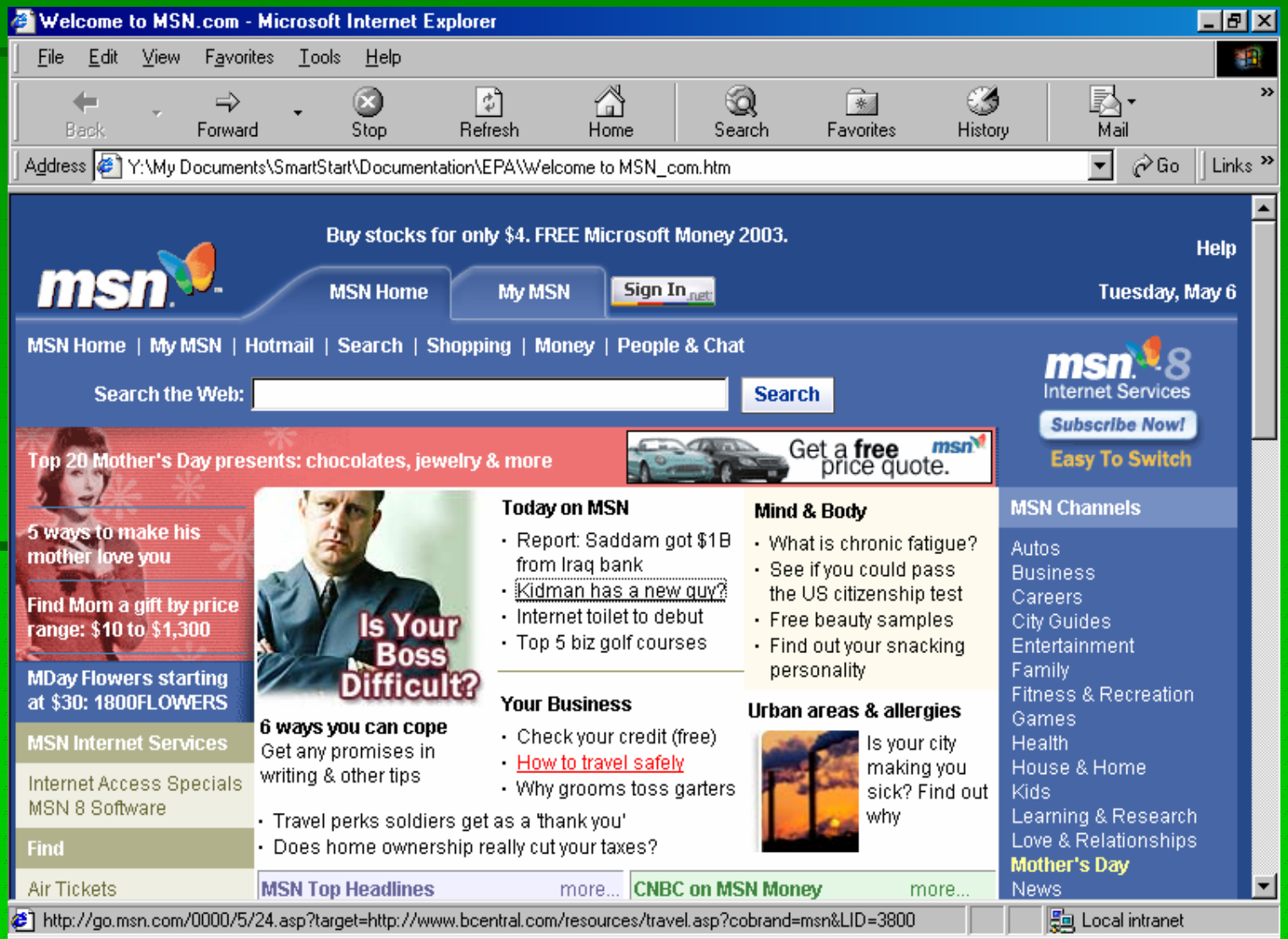
We have been.....

Transmission Path

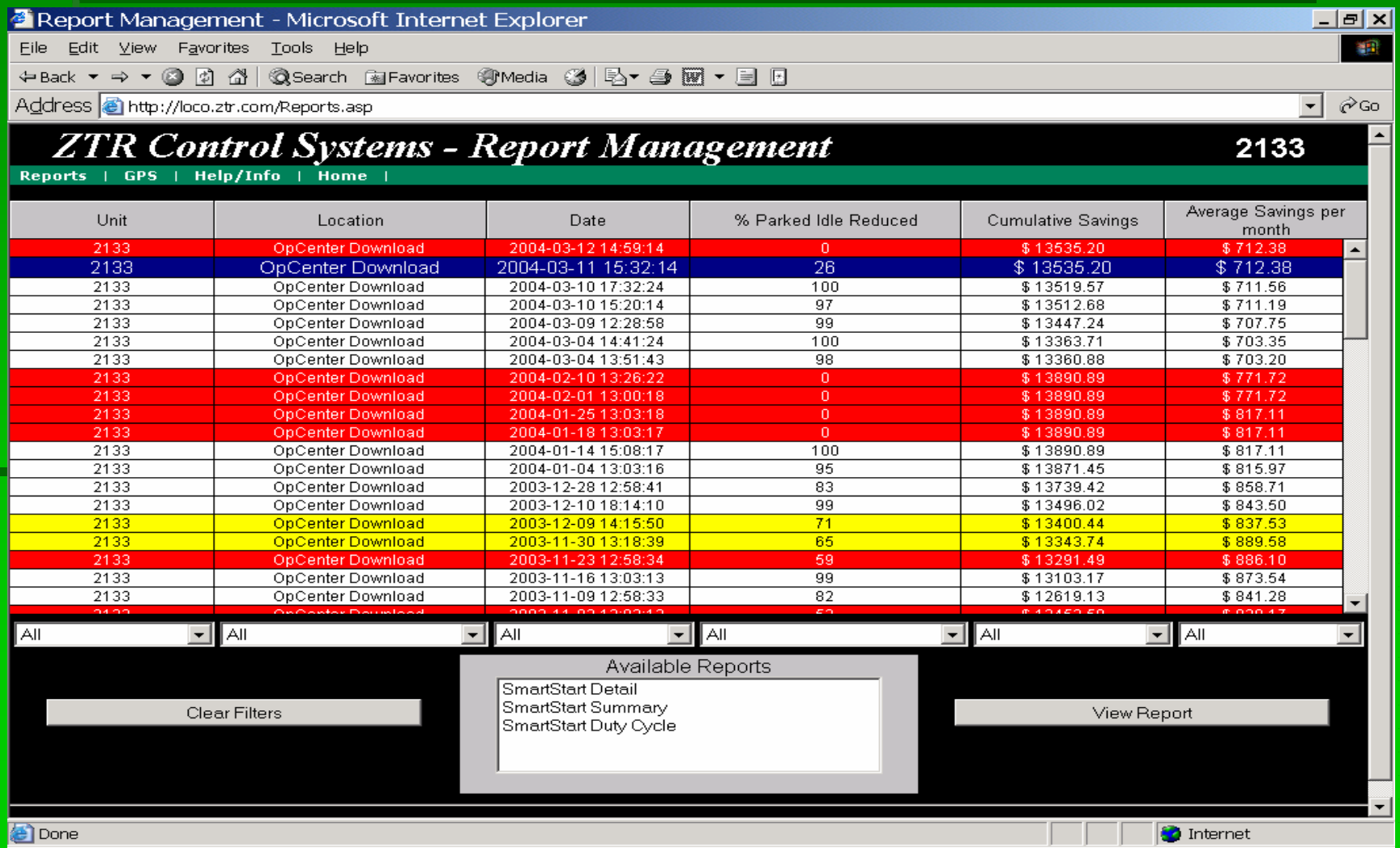
Satellite Link

Operations Center Service

Access through the Internet



Performance at a Glance……



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SmartStart - Hotstart Detail Report

Rail Road: Burlington Northern Santa Fe **Location:** OpCenter Demo
Road Number: 2133

HOTSTART

Reporting Period

	Installation	Previous Report	Current Report		Since Installation	Previous Report
Date:	8/30/2002	1/25/2004	2/1/2004	**Days:**	520.0	7.0
Time:	13:07:45	13:03:18	13:00:18	**Hours:**	12479.9	168.0

Locomotive Operating Statistics (Hours)

	Since Installation			Since Previous Report		
In Service Hours:	10147.5	=	422.8 Days	168.0	=	7.0 Days
Out of Service Hours:	2332.4	=	97.2 Days	0.0	=	0.0Days

	Since Installation	Since Prev. Report		Since Installation	Since Previous Report
ENGINE SHUTDOWN:	4953.0	0.0	**IDLING:**	4356.2	145.9
Manual:	1859.9	0.0	**Working Idle:**	2747.0	69.8
SmartStart:	3093.1	0.0	**Parked Idle:**	1609.2	76.1
ENGINE RUN:	5194.5	168.0	**PARKED IDLE:**	1609.2	76.1
Loading:	838.3	22.1	**Unavoidable Idle:**	790.1	32.6
Idling:	4356.2	145.9	**Manageable Idle:**	819.1	43.5

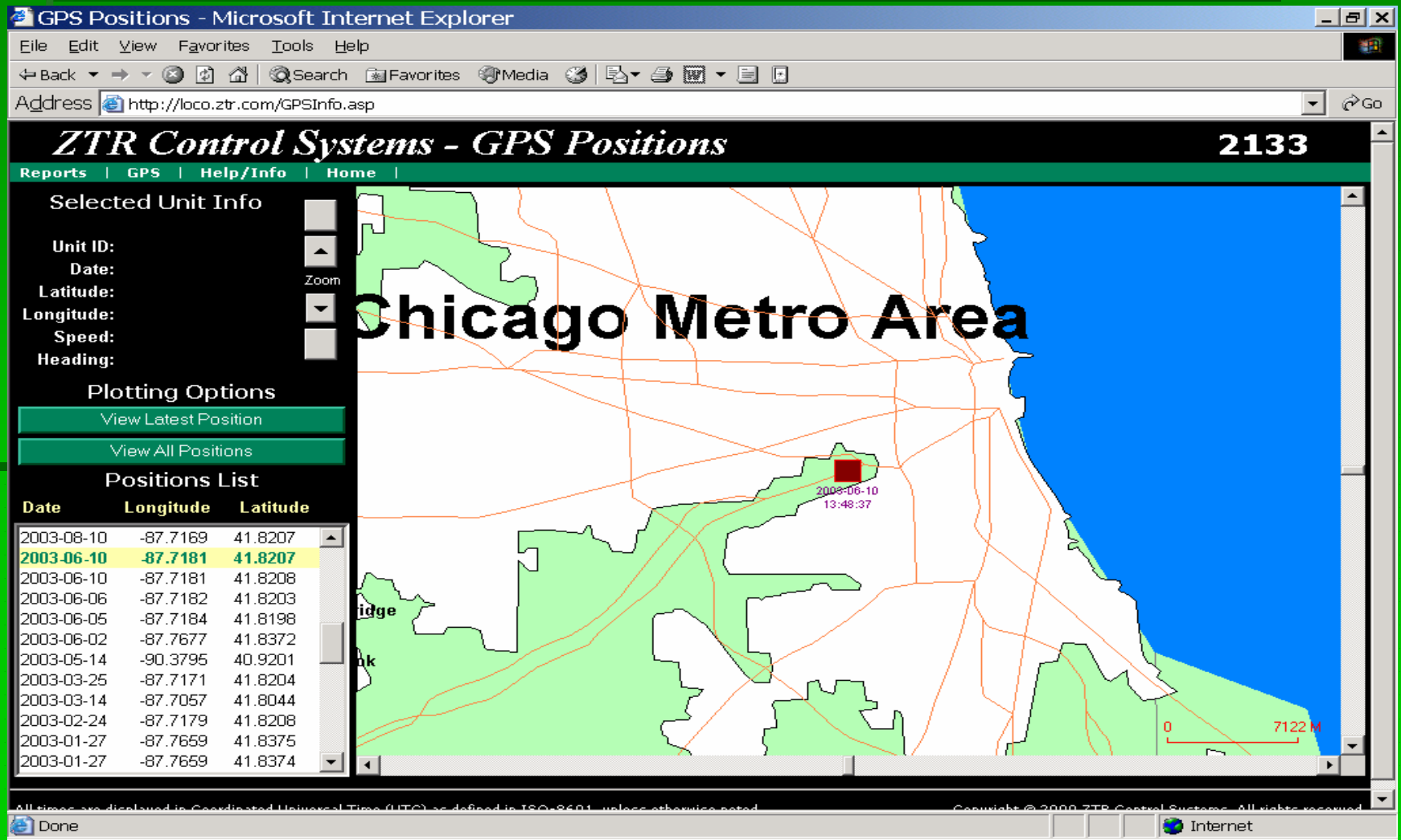
Unsatisfied Parameters Preventing Shutdown (Hours)

		UNAVOIDABLE			
Ambient Temp:	644.5	32.5	**Water Temp:**	55.9	0.0
Dump Valve Temp:	84.2	0.1	**High Water Temp:**	0.0	0.0
		MANAGEABLE			
Brake Pressure:	464.7	76.2	**Battery Voltage:**	0.0	0.0
Battery Charging:	142.8	0.1	**Extended Idle:**	14.7	0.0
Reverser not Centered:	280.8	0.0	**SS Switch Off:**	30.3	0.0
System Override:	132.6	0.7			

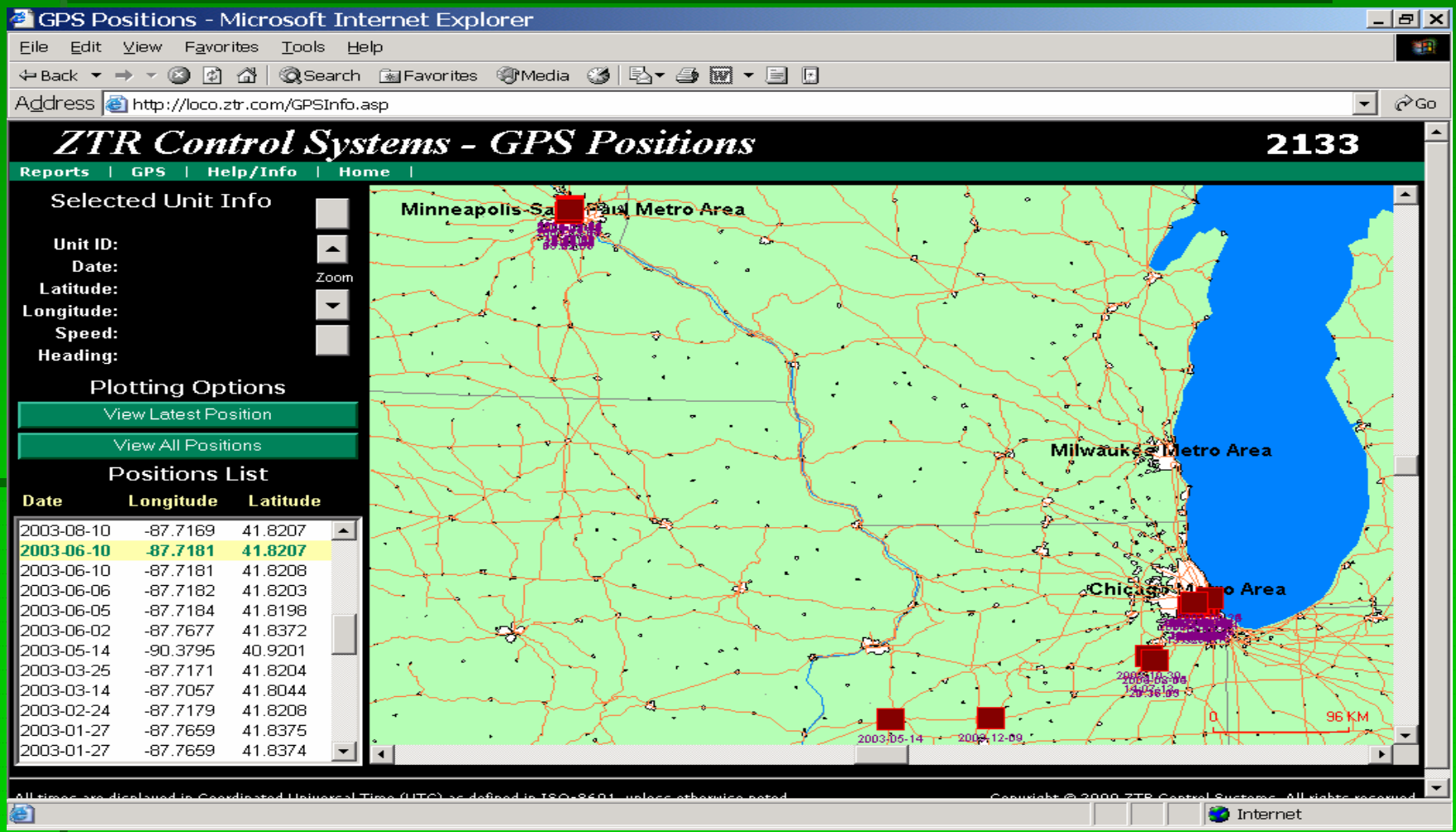
Reason(s) for Restart After SmartStart Shutdown (Counts) - Hotstart Shutdown (Counts)

Brake Pressure:	229	0	**Ambient Temp:**	18	0
Water Temp:	133	0	**Battery Voltage:**	0	0

GPS Latest Position.....



GPS Historical View.....



In closing, I would like to say that ZTR Control Systems has been in the business of making the reduction of emissions a win-win situation for locomotive owners and the environmental community, for over 15 years. We plan to stay the course and to offer solutions that will continue this tradition. Let us know how we can help.

Thank You